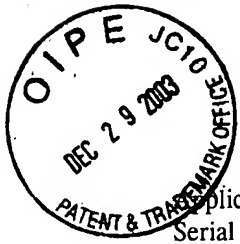


PATENT

Docket No. 979-041



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s) : TBA
Serial No. : 10/716,184
Filed : November 18, 2003
For : METHOD FOR CONDUCTIVELY CONNECTING FIRST AND SECOND ELECTRICAL CONDUCTORS

CERTIFICATE OF MAILING (37 C.F.R. 1.8a)

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Respectfully submitted,

SOFER & HAROUN, L.L.P.

By: *Sandra Cirillo*
Sandra Cirillo

Date: 12/23/03

Mailing Address:

SOFER & HAROUN, L.L.P.
317 Madison Avenue, Suite 910
New York, New York 10017
Tel:(212)697-2800
Fax:(212)697-3004



Docket No.: 979-041

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In re Application of

TBA

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-----X

COMMUNICATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

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Respectfully submitted,

SOFER & HAROUN, LLP

By


Joseph Sofer, Esq.

Reg. No. 34,438

317 Madison Avenue, Suite 910

New York, New York 10017

(212) 697-2800

Dated: December 23, 2003



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Bekreftelse på patentsøknad nr
Certification of patent application no

20025747

► Det bekreftes herved at vedheftede dokument er nøyaktig utskrift/kopi av ovennevnte søknad, som opprinnelig inngitt 2002.11.29

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Alm. tilgj. 1 JUN 2004
Fremgangsmåte for ledende sammenkopling av to elektriske ledere

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Fig. nr. 2

PATENT 83563-BE

02-11-2002 23747

1

Method for conductively connecting two electrical conductors

Description

The invention is concerned with a method for conductively connecting two electrical conductors consisting of different materials and having different diameters.

(EP 0 852 245 A2).

Such a method is used, e. g. for the connection of a smaller resistance conductor of a heating cable and a larger so called "cold conductor" made of copper for the connection with a power supply. A resistance conductor typically is made of NiCr-alloy. Such a conductor can not be connected to a copper conductor by traditional welding methods. Soldering both conductors causes problems by carbon inclusions in the splicing area with a reduced electrical conductivity. The same problems arise when other electrical conductors of different materials shall be connected.

According to the known method of EP 0 852 245 A2 mentioned above, which is concerned with the connection of a smaller resistance conductor and a larger copper conductor, first the end of the copper conductor is reduced to a smaller diameter. Both conductors then are connected by a crimp connector with a diameter that not exceeds the diameter of the copper conductor. The crimp connector is an additional element. It makes the splicing expensive. The connection has a relative high contact resistance and can cause problems during an extrusion process for applying an insulation sheath to the conductors.

An object of the invention is to improve the method described above, to achieve a good conducting splice and a guidance through an extruder for applying an insulation sheath without disturbances.

That is achieved by the following features of the invention:

- at first the ends of the two conductors are brought into mechanical contact with each other in an overlapping position,
- at second the two conductors are connected to each other by welding without feeding of additional welding material and
- at third the overlapping area is formed mechanically to achieve a smooth diameter transition between the two conductors.

With this method the materials of the conductors are transferred into a molten condition without additional feeding of a separate welding material. After cooling the two conductors surprisingly are connected very fast to each other although they are made of different materials, e. g. different alloys. The method provides mechanical tensile strength in the splicing area and a dimensional smooth diameter transition between the smaller diameter conductor and the larger diameter conductor. This makes it possible to process the welded conductors through an extrusion head of an ordinary insulation extrusion line with a guide and a die where the insulation material is applied under significant pressure. A sharp shift between the two conductors, which would meet resistance passing through the pressurised plastic mass in the extrusion head, is avoided. In addition, the splicing area maintains its ductility. This is good for the manufacturing process, as the joint conductor has to pass through several pulleys.

The method of the invention is described in the following with a preferred embodiment in conjunction with the drawings.

The drawings show:

Fig. 1 schematically a heating cable with a connected supply cable,

Fig. 2 six stages of a process to carry out the method of the invention,

Fig. 3 and 4 details of the conductors to be connected in enlarged scales.

In the embodiment of the description the method of the invention is explained with use of ultrasonic welding. Nevertheless other welding methods without feeding of additional welding material, like TIG (Tungsten Inert Gas)-welding, Laser-welding and HF (High Frequency)-welding, also shall be covered. In addition the method is explained for the connection of a smaller resistance conductor to a larger copper conductor. Nevertheless other conductors with different materials, e. g. alloys, also shall be covered.

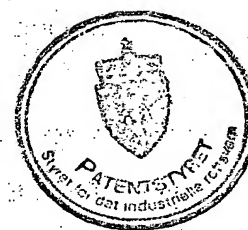
Fig. 1 schematically shows a heating cable 1 which is mounted in the floor of a building (not shown) meander-shaped. The heating cable 1 comprises a resistance conductor 2 and a copper conductor 3 (Fig. 2 to 4) which are connected to each other in a splicing area 4. The conductors 2 and 3 are enclosed into a sheath of insulating material which can be applied by an extrusion line (not shown). The resistance conductor 2 has a smaller diameter than the copper conductor 3. Both conductors 2 and 3 are connected to each other in the splicing area 4 as follows:

The two conductors 2 and 3 are brought into mechanical contact with each other in an overlapping position, according to Fig. 2a. In this position they are placed in an ultrasonic welding machine 5 and welded to each other (Fig. 2b). That means, the materials of the two conductors 2 and 3 are molten by ultrasonic energy and therefrom after cooling are connected to each other without additional welding material in a connection with high mechanical tensile strength. The connected conductors 2 and 3 with their splicing area 4 are shown in Fig. 2c.

The splicing area 4 now is formed mechanically to achieve a smooth diameter transition 6 between the two conductors 2 and 3 as shown in Fig. 2e. The mechanical deformation is indicated in Fig. 2d by four rollers 7. It can be done e. g. by milling, rolling or forging.

Prior to welding of the two conductors 2 and 3 it is possible to prepare the end of the larger copper conductor 3 according to Figs. 3 and 4. So it is possible to split the end of the copper conductor 3 in axial direction into at least two parts 8 and 9 between which the resistance conductor 2 can be inserted. It also is possible to form a longitudinally extending groove 10 into the end of the copper conductor 3, into which the resistance conductor 2 can be laid.

Both conductors 2 and 3 can be single-wire conductors as described above and shown in the drawings. They also can be - one of them or both - multiwire conductors. Resistance conductor 2 e. g. may be a three - wire conductor connected with a single-wire copper conductor 3 or a seven-wire copper conductor 3. Other numbers of wires in the multiwire conductors also are possible.



Claims

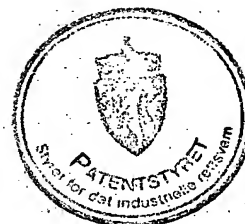
1. A method for conductively connecting two electrical conductors consisting of different materials and having different diameters, **characterized in that**
 - at first the ends of the two conductors (2,3) are brought into mechanical contact with each other in an overlapping position,
 - at second the two conductors (2,3) are connected to each other by welding without feeding of additional welding material and
 - at third the overlapping area (4) is formed mechanically to achieve a smooth diameter transition between the two conductors (2,3).
2. A method according to claim 1, **characterized in that** the two conductors (2,3) are connected to each other by ultrasonic welding.
3. A method according to claim 1 or 2, **characterized in that** before welding the end of larger conductor (3) is splitted in axial direction into at least two parts (8,9) which are laid around the end of the smaller conductor (2).
4. A method according to claim 1 or 2, **characterized in that** before welding the end of the larger conductor (3) is formed with a longitudinally extending groove (10) to receive the end of the smaller conductor (2).
5. Use of a method according to claims 1 to 4 for connecting a resistance conductor for heating cables (1) with a copper conductor.



Abstract

A method for conductively connecting two electrical conductors (2,3) is described which consist of different materials and have different diameters. In carrying out the method first the ends of the two conductors are brought into mechanical contact with each other in an overlapping position. The two conductors (2,3) then are connected to each other by welding without feeding of additional welding material. Finally the overlapping area (4) is formed mechanically to achieve a smooth diameter transition between the two conductors (2,3).

Figure 2.



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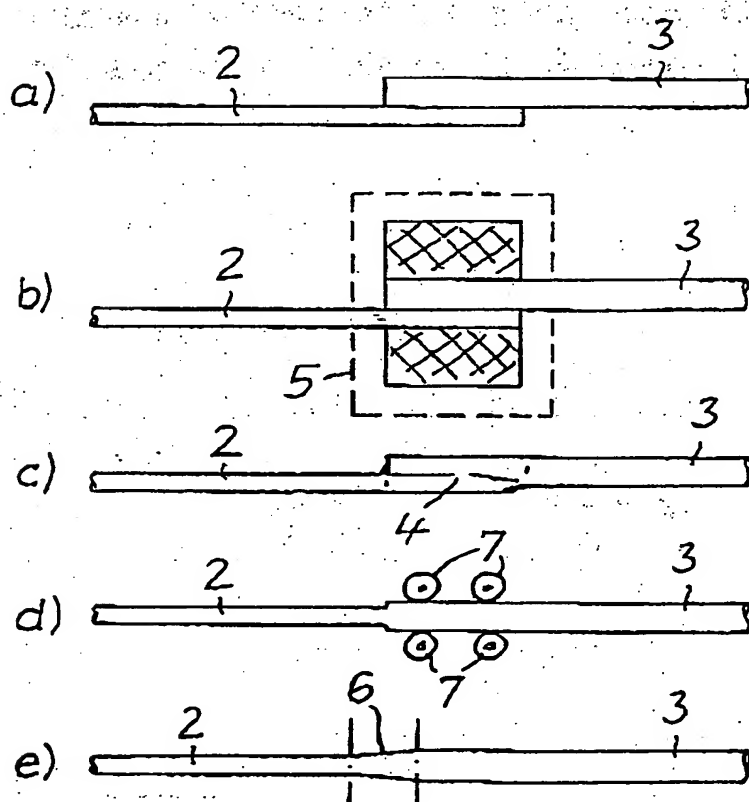
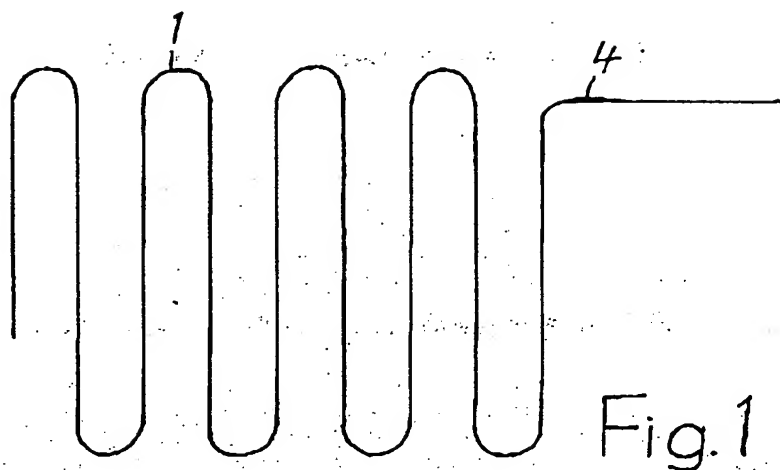


Fig. 2



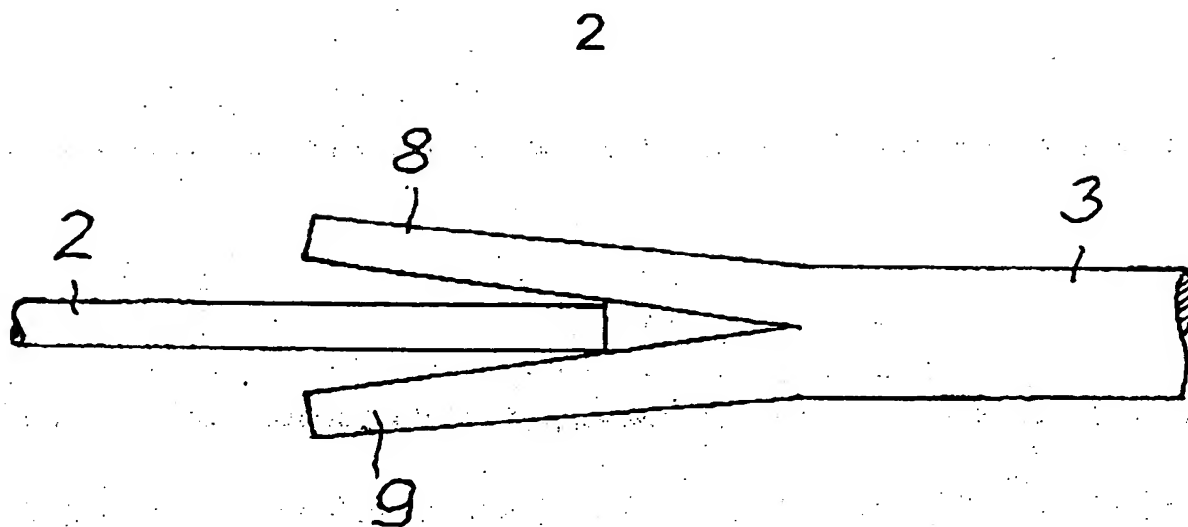


Fig. 3



Fig. 4

